

***Basin Electric Power Cooperative  
Laramie River Station  
Best Available Retrofit Technology***

***Control Technology Cost Estimates***

***July 26, 2013***

## *Introduction*

- Sargent & Lundy
  - Independent engineering/design/consulting firm
  - 120 years of electric power industry experience
  - Focused exclusively on the power generating industry
  - More than 150 fossil-power clients
  - S&L has completed some 72 Selective Catalytic Reduction (SCR) projects representing more than 37,000 MW of generation, the most of any design/engineering company in the U.S.

## *Introduction*

- Basin Electric retained S&L to:
  - Develop site-specific cost estimates for SNCR and SCR at the Laramie River Station (LRS) in accordance with the BART Guidelines; and
  - Compare those costs to the cost estimate prepared by EPA's consultant Andover Technologies
  - Cost is a key parameter in a Best Available Retrofit Technology (BART) Determination

## *Introduction*

### **Sargent & Lundy**

- Followed the BART Guidelines in EPA's Regulations (40 CFR Part 51 Appendix Y)
- Followed, where possible, the approach described in EPA's *OAQPS Control Cost Manual*
- Developed costs "taking into account site-specific design or other conditions . . . that affect the cost of a particular BART technology option."\*

\*BART Guidelines

### **Andover Technologies\***

- Calculated costs using EPA's Integrated Planning Model (IPM) cost algorithms, which was never intended to be used for this purpose
- Relied on aerial photographs, which do not provide significant site-specific information, to identify site-specific conditions and determine site congestion and construction challenges

\*Andover Technology Partners, *Review of Estimated Compliance Costs for Wyoming Electricity Generating Units (EGUs)* – revision of previous memo, February 7, 2013.

## *Introduction*

- This presentation focuses on cost estimates prepared to install SCR control systems on LRS Units 1, 2 & 3
- S&L reviewed the cost estimates provided in the Andover Report and found at least three fundamental errors and omissions which render the costs grossly inaccurate:
  - First, Andover used the IPM cost model to calculate control system costs
  - Second, Andover failed to take into account site-specific conditions
  - Third, Andover failed to include costs for balance-of-plant systems required for the SCRs

## ***IPM Cost Algorithms Do Not Calculate Project-Specific Costs***

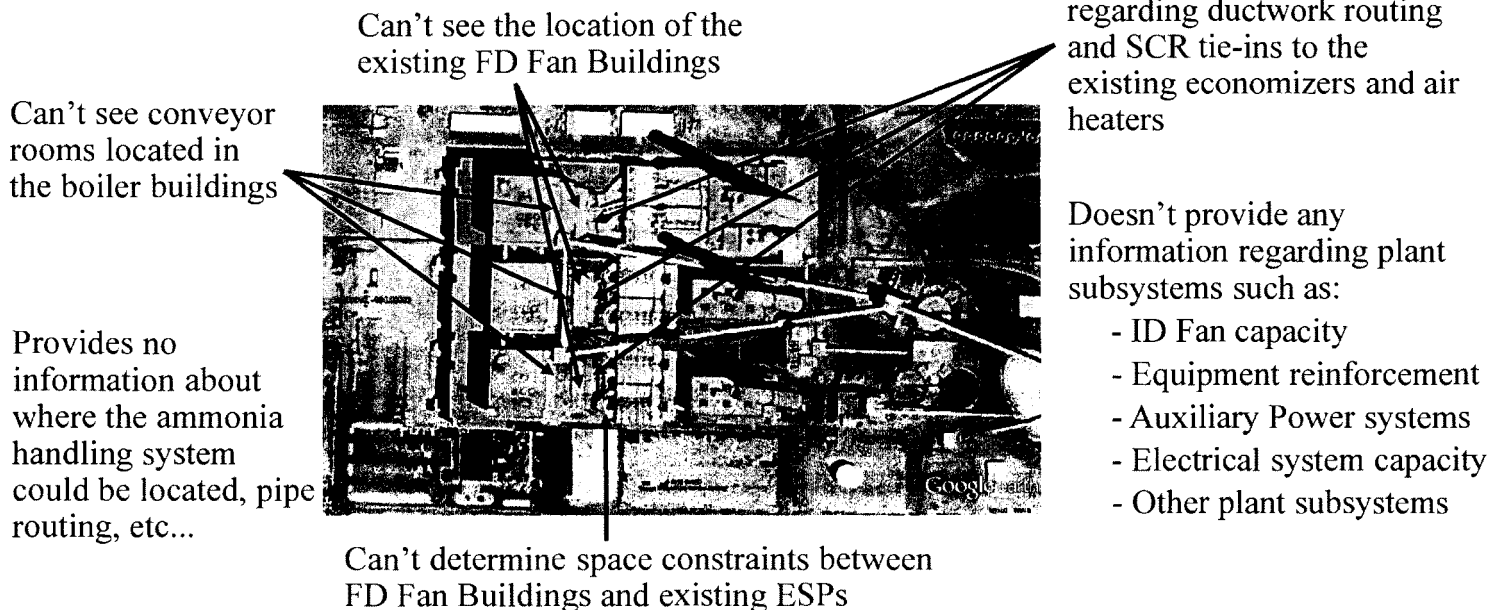
- IPM cost modules were developed by Sargent & Lundy to evaluate system-wide impacts of regulatory programs, and not site-specific costs
- Inputs to the IPM model are limited to unit size, heat rate, coal type, and a subjective retrofit factor
- IPM cost algorithms do not take into consideration site-specific conditions that “affect the cost of a particular BART technology”

## ***Andover Failed to Take Into Consideration Site-Specific Conditions that Affect SCR Costs***

- Site-Specific Conditions Andover Failed to Consider Include:
  - Site Elevation:
    - » LRS is situated at 4,750 feet MSL
    - » Flue gas volume will be approximately 20% greater than a similarly sized unit at sea level
    - » Larger flue gas volumes require a larger SCR reactor, larger duct work, increased structural support – all increasing SCR capital costs
  - Regional Labor Productivity Factor
    - » Regional productivity must be taken into consideration in a site-specific cost estimate to account for local workforce characteristics, labor availability, project location, project complexity, local climate and working conditions

## ***Andover Failed to Take Into Consideration Site-Specific Conditions that Affect SCR Costs, cont'd.***

**Andover's only attempt to account for site-specific conditions was to look at an aerial photograph:**





## ***Sargent & Lundy Evaluated Site-Specific Conditions and Took Them Into Account***

- To determine site-specific conditions and constraints, S&L:
  - conducted a site walk down
  - established control system design parameters
  - prepared site-specific general arrangement (GA) drawings
  - identified site-specific construction challenges
  - reviewed existing plant subsystems
  - determined capital costs based on the design parameters, GA drawings, site congestion, and existing plant conditions

## ***Sargent & Lundy Evaluated Site-Specific Conditions and Took Them Into Account, cont'd.***

### **Site-specific conditions that need to be considered to install SCR at LRS:**

1. Due to the location of conveyors & conveyor rooms SCR duct work must go through the side of the existing boiler building:
  - a. SCR ductwork will penetrate the existing boiler building structural columns
  - b. Boiler building structural supports must be redesigned and rebuilt
2. SCR Reactors will be located directly above the existing FD Fan Buildings
  - a. SCR support columns will have to penetrate the FD fan buildings
  - b. Construction of deep foundations for the SCR support columns will be challenging and time consuming
3. Location of the existing coal conveyors dictates the need for special cranes to provide the lifting capacity required to install the SCRs

## ***S&L Considered Site-Specific Factors that Andover Did Not***

### **Plant sub-systems that need to be upgraded, replaced, or installed to support SCR operation at LRS:**

- » Larger ID Fans will be required on all three units, requiring ID Fan replacement;
- » Existing electrical systems are not capable of handling the new fan loads and SCR control systems, and will require significant upgrades;
- » Structural stiffening of the ductwork downstream of the air heater and upstream of the new ID fans will be required by NFPA regulation;
- » The existing DCS system needs to be expanded; and
- » DSI control systems will be required on LRS Units 1 & 2 for SO<sub>3</sub> mitigation

## ***S&L SCR Capital Costs - Taking into Consideration Site-Specific Conditions***

	Unit 1	Unit 2	Unit 3
Total Direct Costs	\$150,424,000	\$159,671,000	\$155,326,000
Total Indirect Costs	\$91,046,000	\$96,210,000	\$94,229,000
Total Capital Investment	\$241,470,000	\$255,881,000	\$249,555,000

**Direct Costs Include:** equipment, material, and labor; plus spare parts, special tools, consumables, and freight. Total project costs include equipment costs for the SCR, ammonia handling system, and balance-of-plant systems including the ID fan, auxiliary power system, electrical system, and DSI control systems on LRS Units 1 & 2.

**Indirect Costs Include:** general facilities, engineering & home office fees, contingencies, preproduction costs, and initial catalyst fills. See, Control Cost Manual, Section 4.2, Chapter 2, page 2-44.

# Capital Cost Estimate Comparison

Total Capital Investment	S&L	Andover
Unit 1	\$241,470,000	\$102,368,532
Unit 2	\$255,881,000	\$119,799,473
Unit 3	\$249,555,000	\$106,092,118
Total	\$746,906,000	\$330,000,000
<u>Site-Specific Cost Consideration</u>		
Site Elevation:		~\$60 MM
Regional Productivity Factor:		~\$60 MM
Site Congestion:		~\$120 MM
Balance-of-Plant Subsystem Upgrades:		~\$170 MM
Other Indirect Costs:		~\$50 MM
Total Excluded Costs:		~\$460 MM

## ***SCR Cost Effectiveness at Laramie River Station***

Table 1. SCR Cost Effectiveness at Laramie River Station. Data are presented in thousands of dollars unless otherwise indicated. Data are presented in thousands of dollars unless otherwise indicated. Data are presented in thousands of dollars unless otherwise indicated.

<b>Total Annual O&amp;M Cost</b>	<b>Unit 1</b>	<b>Unit 2</b>	<b>Unit 3</b>
Annualized Cost of Capital	\$25,485,000	\$26,846,000	\$26,248,000
Total Annual O&M Costs – SCR	\$5,316,000	\$5,352,000	\$5,096,000
Total Annual Costs (S&L)	\$30,801,000	\$32,198,000	\$31,344,000
Total Annual Costs (Andover)	\$15,878,000	\$17,749,000	\$16,328,000
NOx Emission Reductions*	3,324	3,305	3,391
SCR Cost Effectiveness (S&L)	\$9,266	\$9,320	\$9,083
SCR Cost Effectiveness (Andover)	\$4,777	\$5,370	\$4,815

\*For consistency, annual NOx emission reductions are based on a controlled NOx emission rate of 0.19 lb/MMBtu with combustion controls (Andover Report, pg. 15-16) and EPA's controlled NOx emission rate of 0.05 lb/MMBtu with SCR (Andover Report, pg. 15-16). Annual emission reductions were calculated for each unit based on the full load heat inputs and annual capacity factors summarized in the Andover Report for each unit.

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## *Cost Conclusions*

1. Andover did not follow the BART Guidelines or EPA's Control Cost Manual
2. Andover used the IPM cost model that was never intended to calculate unit-specific costs
3. Andover completely failed to consider site specific conditions that will affect the cost of SCRs at the Laramie River Station
4. Andover failed to include balance-of-plant costs required to operate the SCR control systems
5. Andover's errors and omissions result in a cost estimate that is 50% or less than the cost of SCR at Laramie River
6. Thus, basing the Laramie River BART Determination on Andover's cost estimates would be arbitrary and capricious